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Anirudh Dhebar
Sloan School of Management
Massachusetts Institute of Technology
38 Memorial Drive, E56-329
Cambridge, Massachusetts 02142-1347

Telephone: (617) 253-5056
e-mail address: adhebar@mit.edu

New-and-Improved High-Tech Products: Speeding Producer, Meet the Balking Consumer

Anirudh Dhebar

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New-and-Improved High-Tech Products: Speeding Producer, Meet the Balking Consumer

Abstract

All sorts of products, it seems, are being rendered “smart” and “high-tech” by the increasingly ubiquitous microprocessor, and hardware producers and software developers are falling over each other to be first to market with even-newer-and-even-more-improved versions. They should constantly be asking the question, “What would consumers, especially consumers who have ‘internalized’ the existing version, think of the pace of product improvement?” To use information technology intensive products effectively, consumers often must make long-term (financial and non-financial) investments in the product and/or the overall system in which the product is used, and once the investment is made they expect to be able to complete a certain expected number of consumption cycles before having to repeat the investment. The rapid introduction of new-and-improved versions can throw a wrench in the consumer’s product-purchase and consumption calculus. It can make the consumer regret the act and timing of a previous purchase, hesitate over any new purchase, and agonize over similar situations in the future. In a sentence, consumers may balk, and this cannot be in the producer’s long-term interest. This article articulates the underlying reasons for—and the consequences of—adverse consumer reaction to rapid product improvement and offers suggestions for mitigating some of these reactions.

Introduction

I purchased my first car (a Honda Civic) and my first personal computer (an IBM PC AT) at about the same time (the mid-1980s) and for about the same price (\$6,000-\$7,000; the price of the computer was inclusive of a monitor and a printer). Both products were what economists call “durable goods”; both were used in larger systems consisting of the user, complementary products, and infrastructure; both required mastering complex user interfaces and protocols; and in both cases the manufacturers followed up the initial models with a sequence of “new-and-improved” versions. My experiences owning and replacing the two were, however, very dissimilar.

An annual stream of new-and-improved Civics notwithstanding, I used my car for eleven years, for the most part with satisfaction, and easily disposed it off for just under a third of the original purchase price. As basic transportation goes, the new car I purchased as a replacement was not much more superior, but it was much more expensive and, given the rate at which car prices were rising, I was glad I replaced my car when I did and not later.

My experience with the personal computer was very different: I could barely squeeze three years out of it (not because the computer itself was wearing out, but because it was soon not powerful enough for me, my software, my display monitor, or my colleagues); at the end of three years, I had to practically give it away; and when it came to a replacement unit, I looked at the stream of cheaper, even-newer-and-even-more-improved computers, monitors, software, printers, and so on, reflected on my experience, and tried my best to put off its purchase. I felt like I was playing a game in which the consumer could never win. Regret (over my past purchase), hesitation (over a replacement purchase), and anxiety (about future trends for all the different components of the system) seemed the only outcomes one could be sure of. I was, to put it mildly, not happy.

I suspect I am not the only consumer who feels somewhat helpless when coping with the steady stream of even-newer-and-even-more-improved personal computer related products. Take the following quote from a story in *The Wall Street Journal*:

In the beginning, there was Microsoft Word 1.0, and it was good. But it wasn't perfect. So Microsoft Corp. developed upgrades: Word 2.0, 3.0, 4.0, and 5.0.

Microsoft isn't alone. The entire software industry has embraced upgrades with a devotion to the "new and improved" that would shame a soap maker. ...

While such upgrades usually include many worthwhile features, consumers increasingly are balking at trading up. "A lot of people don't need to upgrade as often as the vendors offer upgrades," says ... [the] president of the Boston Computer Society, ...

"[I]t seems to me upgrades are nothing but bad news," says ... [the] director of information technology for [one of the divisions] of Hercules, Inc., Wilmington, Del. She complains about the complex process of exchanging every user's old disks for new ones and the time it takes to teach users about new features.¹

In the five years that have elapsed since the above story, computer hardware and software suppliers have not slowed down the pace of new-and-improved offerings:

Every few months there's a new generation of something—hardware or software that increases the speed or power of a computer system. Advertisements trumpet each breakthrough and it's left to consumers to determine whether the additional power is worth the investment.²

The determination is not easy given the multi-component nature of computer systems, the standards-still-being-established phase of the industry, and the fact that the different system components follow their own equivalent of so-called Moore's law ("computer chips double in power every [eighteen months, revised in 1975 to] two years"). The demand consequences for new-and-improved hardware and software can be worrisome:

Will the mass movement of computers into homes be stymied by consumers' fears that whatever they buy will instantly be out of date? [A reader in Dallas]

¹ Bulkeley, William M. "Software Users Are Beginning to Rebel Against the Steady Stream of Upgrades," *The Wall Street Journal*, September 20, 1990, p. B1.

² Mills, Joshua. "Revving Up Computers With New CD Drives," *The New York Times*, August 10, 1995, p. C2.

wonders, is technology changing so fast that “the cart is going downhill faster than the horse?”³

While the case of computer hardware and software is the most compelling, the sense that “the cart may be going downhill faster than the horse” extends to other product categories as well, many but not all revolving around the increasingly ubiquitous microprocessor.

The reader need not look far for a validation of this assertion. Take the telephone, the food processor, the camera, the home entertainment system, the office copier, or factory automation equipment. All durable goods, all used in a system environment, and all being continuously and significantly improved as rival designers try to outdo each other at putting microprocessors to greater and smarter use. Have you ever sensed that no sooner have you purchased one version of the product, learned how to use it, and acquired the necessary accessories that there is an even-newer-and-even-more-improved version—often, even at a lower price? And what has been your reaction? If the answers are, “Yes” and “Not happy about it,” then you are not alone:

In the face of a touch-tone tidal wave, many of the nation’s dialers are refusing to scrap their rotaries for the latest Trimline or cordless phone. “I just prefer to keep things slower,” explains [an Atlanta resident with nine rotary phones]. “I don’t like how things get faster and faster.”⁴

As I reflect on these examples, three questions come to mind. One, what would explain the consumer reactions suggested in the above examples: are the consumers just being unreasonable, or is there substantive basis for their reaction—basis that can be conceptually articulated? Two, are there any generalizable implications in terms of consumer reaction—implications that producers racing to introduce new-and-improved versions of products should bear in mind? And three, what, if anything, can the producers do to mitigate the negative reactions suggested in the examples?

³ “Bulletin Board,” *Business Week*, July 11, 1994, p. 24.

⁴ De Lisser, Eleena. “If You Have a Rotary Phone, Press 1: The Trials of Using Old Apparatus,” *The Wall Street Journal*, July 28, 1994, p. B1.

New-and-Improved Versions of High-Tech Products: Why Consumers Care About the Pace of Improvement

Consider a “high-tech” (in particular, information technology intensive) product that has been on the market for some time. We enter the story at the time of the introduction of a new-and-improved version. The version is indeed improved: if consumers could make a fresh choice—a choice unencumbered by investment in or habituation with the existing version of the product—then they would pick the new version over the existing version. We assume that the producer has set the other marketing mix variables such as price, distribution, and communications so as to support such choice.

A better product and right price, distribution, and communications, and the pieces seem to be in place for an enthusiastic market response to the new-and-improved version. Or are they? Specifically, does it matter how soon after the existing version the new version is introduced? And why?

To answer these questions satisfactorily, we must understand the nature and durability of the consumer’s investment in the product and, importantly, the overall system in which the product is used.

Consumers Make Durable Investments in Products—and in Overall Systems

The products cited in the introductory section—computer hardware and software, telephones, food processors, cameras, home entertainment systems, office copiers, factory automation equipment, and so on—have a number of things in common:

- (1) They are all durable products—products that consumers expect to use repeatedly over an extended period of time. When consumers purchase these products, they make a long-term investment in them and, in return, acquire the right to a long-term consumption stream. The consumption stream has maximum value when the product is new, but goes down as the product gets older (with a finite product life, there are fewer remaining consumption possibilities and, in any case, product performance

may deteriorate with use, consumer needs may grow, and/or consumers may get bored with the old and start craving for something new).

- (2) Many of these products are used not in isolation but with one or more complementary products in integrated, multi-component systems (examples: computer hardware and software, cameras and lenses, amplifiers and speakers, copiers and printers as nodes in an office local-area networks, and factory automation equipment as part of a computer-integrated manufacturing system). To use the products effectively, consumers must invest in other system components as well, and this investment can exceed the investment in the product itself (example: in 1980, I purchased a single-lens reflex camera body, a Nikon FE, for \$250; my total investment over the next three years in lenses, filters, and converters was over \$1,000).
- (3) Getting a multi-component system to work properly almost always requires more than just placing the individual components next to each other. Interfaces must be defined, connections must be made, compatibility must be established, and information must often be exchanged. Putting all this together may entail yet additional investment—not only financial investment, but also investment of time, energy, and other organizational resources.
- (4) Most of the products in question require human operation and, recent emphasis on user friendliness notwithstanding, ease of use is not a particularly strong point for these products.⁵ The average consumer often must invest significant time, energy, and, on occasion, frustration in learning—let alone mastering—the use of the product as well as other components of the system. These learning costs, high enough in the single-user case, quickly escalate in a multi-user organization and

⁵ "Work on the interface between human and machine already consumes three-quarters of the development work on electronic products, says Gary A. Curtis, a Boston Consulting Group Inc. vice-president and leader of its worldwide information-technology practice. Nonetheless, technology keeps getting more costly in terms of the time required to master it." ("The Technology Paradox," *Business Week*, March 6, 1995, 76-84; the quote is on p. 80.)

dwarf the initial investment in the product itself. (Citing a Gartner Group Inc. study, a recent *Business Week* article states: "The initial purchase price of a corporate personal computer accounts for only 10% of its lifetime cost. The rest: trouble-shooting, administration, software, and training."⁶ Throw in the telephone, the facsimile machine, the copier, the printer, the projection system, even the coffee machine, and very soon you are talking about a substantial investment in something very intangible—the ability of an organization's employees to use these productivity-enhancing resources.)

Points (1) through (4) have major implications for how consumers respond to a new-and-improved product version.

Why the Pace of Product Improvement Matters

Let us begin with a case where only the first of the above four points applies: we have a product that is durable and can be used without any additional investment in complementary products, user learning, or system infrastructure. What happens when the supplier of the product introduces a new-and-improved version: will consumers purchase the new version, or will they hesitate?

The answer depends, among other things, on whether a given consumer is an adopter of the existing version, an adopter of a competing version, or a non-adopter (who would be purchasing into the given product category for the first time). The non-adopter's decision is the easiest to analyze: by assumption, the new-and-improved version is indeed improved and, given the absence of any past ties with the product, non-adopters can decide on the new-and-improved version on its own merits, purchasing it if their valuation of the product exceeds its price, and not otherwise.

Next, take the existing-version adopter. His or her reaction to the new-and-improved version depends not only on the amount of improvement but, significantly, also the length of time

⁶ "The Technology Paradox," *Business Week*, March 6, 1995, pp. 76-84; the quote is on p. 80.

that has elapsed since the introduction of the existing (pre-new-and-improved) version. The existing-version adopter cares about the amount of improvement *and* the pace, or speed, of improvement (the ratio of amount of improvement and the inter-version time).

Formally, say the existing-version adopter purchased the existing version of the product at the time of the version's introduction, at $t = 0$. By purchasing the product, he or she acquired the rights to a consumption stream. Let the value of the stream at time t be $u(t)$. For most products, u decreases over time (see *Figure 1*):⁷ the consumption stream has maximum value ($u(0)$) when the product is new, but goes down as the product gets older.

[INSERT FIGURE 1 HERE.]

Of course, the consumer does not secure the consumption rights for free: the product under consideration must be purchased, and this costs r (note: $u(0) \geq r$; otherwise, the consumer would not have purchased the product in the first place). Once the product is purchased, however, the relevant investment in the product is not the price paid at the time of purchase, but the proceeds the consumer would realize if he or she were to dispose of the product (the "disposal value"). Like the future-consumption-stream value, the disposal value also typically decreases over time (*Figure 1*: "disposal value (d)"). The difference ($u(t) - d(t)$) measures the consumer's expected surplus—the difference between the value of future consumption stream and the contemporaneous investment in the product at time t .

Some comments on the shapes of the curves represented in *Figure 1* are in order. First, there typically is a significant drop in a product's disposal value at the time of purchase. The drop (r -

⁷ *Figure 2* represents the normal case. If "network externalities" are present (consumption benefits increase with the number of users), the value of the future consumption stream may increase as the adopter network expands.

$d(0^+)$), where $d(0^+)$ is the disposal value just after purchase, represents the premium that consumers pay for a “new” product, be it a refrigerator, a computer, a car, a machine tool, or whatever; the acquisition loses a chunk of value the moment it is out of the merchant’s door and the packing box. Second, while the actual curves may be different than those represented in *Figure 1*, after the product reaches a certain age, the gap between the value of the future consumption stream and the disposal value gets smaller as the product gets older.

Figure 1 is useful in understanding the existing-version adopter’s reaction to a new-and-improved version of the product. Say the value of the future consumption stream for the new version at the time of its introduction is v and the version is offered at price p . By assumption, the new version is genuinely improved ($v > u(0)$) and is priced such that if consumers could make a fresh choice then they would choose the new version over the existing version: $v - p > u(0) - r$.

Two observations follow:

- *Observation 1.* Legitimacy of the “new-and-improved” claim notwithstanding (in the sense just articulated), owners of the existing version may decide against switching (“upgrading”) to the new version when it is introduced in the market.

Explanation. Suppose the new version is introduced at time t . An owner of the existing version will switch to the new version only if benefits of switching exceed the cost of switching, that is, if $v - u(t) > p - d(t)$, or, equivalently, $v - p > u(t) - d(t)$. But these conditions may not hold for relatively small t : we see from *Figure 1* that, for small t , it is possible that $u(t) - d(t) > u(0) - r$ and hence $v - p < u(t) - d(t)$ even though $v - p > u(0) - r$.

- *Observation 2.* The later the new version is introduced, the more willing owners of the existing version are to adopt the new version.

Explanation. For relatively large t , the difference $u(t) - d(t)$ decreases with time. This makes it more likely that the condition $v - p > u(t) - d(t)$ will be met.

The two observations lead to an important conclusion: if a new-and-improved version comes too soon after the introduction of the existing version (in other words, if the pace of product improvement is too rapid), then existing-version adopters may choose not to switch to the new version. Their reluctance to switch is not because they do not value the improvement in and of itself, but because, early in the life of the existing version, the benefits from switching are not commensurate with the costs of switching.

The existing-version adopter's reluctance is perfectly reasonable given that

- relatively early in its life (and, sometimes, for a long time thereafter), the existing version continues to have a satisfactory consumption value for the existing-version adopter;⁸
- the adopter already owns the existing version—and, importantly, has incurred costs (for example, the “newness” premium that was referred to earlier and other first-time transaction costs) that would not be recovered at the time of existing-version disposal but would have to be re-incurred if the adopter were to switch to the new-and-improved version; and
- allowing for inefficient second-hand product markets and transaction costs associated with the disposal of the existing version, the existing-version adopter may not be able to realize the “true” value of the existing version over its remaining life.

The import of these three factors is greater in the earlier stages of the existing version's life and diminishes as the product ages; hence, the existing-version adopter's reluctance to switch to a new-and-improved version if it comes too soon after the existing version.

⁸ Recent emphasis on product quality, longer warranties, and so on, can only extend the period for which the existing version continues to enjoy a satisfactory consumption value. This should cause existing-version adopters to stay with the existing version even longer—all this while suppliers are working overtime to come out even faster with new-and-improved versions.

This reluctance becomes even more pronounced when, as is usually the case, the user must invest not only in the product but also in complementary products, interfaces, and learning—in other words, when all four product characteristics identified earlier apply. To the extent that the existing-version adopter continues to derive satisfactory consumption value from the entire system—and this value does not significantly increase by switching to a new-and-improved version of one component of the system—and to the extent that the consumer's system-wide investment (in complementary products, interfaces, and learning) is neither transferable to the new version nor recoverable from disposal of the existing version, the consumer will be even more reluctant than before to switch.

Two examples illustrate this point. Earlier I alluded to my \$1,000-plus investment in lenses and accessories for my \$250 camera body. That camera body is “manual” and does not offer all the functionality (autowind, autofocus, sophisticated metering, and so on) that the newer, smarter, microprocessor-laden “automatic” camera bodies do. The additional functionality is valuable, and I can see myself writing off of my \$250 investment in the old camera body (after all, I have used it for fifteen years) and replacing it with a new-and-improved one. I balk, however, once I focus on the entire user-camera body-lenses-accessories system. To derive the benefits of autofocus, I would also need to replace my lenses, and I am not yet ready to write off my \$1,000-plus investment in lenses and accessories. In other words, although at the product level my switching benefits are greater than the switching costs, at the system level the switching costs exceed the switching benefits; the result: no new camera body.

The second example was the subject of daily media reports at the time of this article's writing (August 1995) and relates to the Microsoft Corporation's introduction of Windows 95, the much-awaited upgrade of the market-dominant Windows operating system software. Upgrading just the software from Windows 3.1 (the existing version) to Windows 95 (the new-and-improved version) may cost less than \$100, but that does not include the time and the energy the user will have expend unlearning the Windows 3.1 user interface and learning how to use the Windows 95 user interface (the two interfaces are different), and it does not include the price of a new computer

(or of upgrading the old computer's processor, memory, and other accessories) that users of older computers will need to avail themselves of all the benefits that Windows 95 provides. Once we factor in these system-wide considerations, the real switching cost may be not "less than \$100" but "a couple of thousand dollars or more."

A recent article in *The Economist* provides interesting data and representative comments on how these system-wide considerations might affect the market response to Windows 95.⁹ Citing La Jolla, California based Computer Intelligence InfoCorp, the article reports that Windows 95 may "[n]ot [be] for everyone" (see *Table 1*):

For the two-thirds of users who do not have ... [a system with a 486 or Pentium processor and 8 MB or more of memory],¹⁰ the choice is whether to upgrade their existing machines or to buy new ones. Most users could upgrade by purchasing another eight megabytes of memory. However, the price of memory chips may rise as PC makers rush to add memory to all their offerings. There is a chip shortage in the industry already. Add in a new processor, and perhaps a bigger hard disk, and the price of beefing up an average PC to run Windows 95 properly nears \$1,000. Many may prefer simply to cough up the \$2,000 [for a new Pentium, 16 MB based PC].

[INSERT TABLE 1, FIGURE 2 HERE.]

Now, place yourself in charge of computer systems in a large organization, and the costs quickly escalate:

⁹ "The Defenestration of Bill?", *The Economist*, July 8, 1995, pp. 57-58. The quotes in the following two paragraphs are from pages 57 and 58, respectively.

¹⁰ What Windows 95 "really" needs depends on whom you ask; see *Figure 2*.

INTECO [of Norwalk, Connecticut] predicts that corporate users will account for just 20% of those adding the program to old machines in 1995. Indeed, some in the industry suspect that Windows 95 may never dominate the commercial market. Instead they think many corporate customers will stick with the current version of Windows [Windows 3.1] for the next year or so, and then ignore Windows 95 by going straight to its industrial-strength big brother, Windows NT. While the beefier NT needs even more memory (16 megabytes is a start), it delivers more in exchange: better networking, more reliability, faster operations.

The reason why corporations have to wait until "next year or so" before directly switching to Windows NT is that Microsoft is porting the superior Windows 95 user interface to Windows NT. As I heard a commentator explain, "The real solution is the Windows 95 interface with Windows NT plumbing."

The above analysis related to existing-version adopters—consumers who own the existing version and are thinking of switching to a new-and-improved version. Before that, I also commented on the non-adopters' decision (with no investment in the existing version, their decision is not tied to the pace of product improvement). That leaves one consumer segment: competing-version adopters. Their tradeoffs are similar to those of existing-version adopters, except that their concern is the consumption value of the competing version they already own and its disposal value in case they were to get rid of it. These values impact, respectively, their switching benefits and switching costs as they consider a switch from the competing version they own to the new-and-improved version under consideration. I shall leave the details to the reader, but the conclusion is similar to that for existing-version adopters: competing-version adopters will be reluctant to switch if the new-and-improved version is introduced very soon after the competing version.

The Special Case of High-Tech New-and-Improved Products

Reviewing the above discussion—and notwithstanding the Nikon and Microsoft examples—the reader would correctly observe that everything I have said so far would apply,

more or less, to my car as well as my personal computer (or software, phone, camera, and so on). And the reader would be correct: the four product characteristics identified at the beginning of the previous section cannot, in and of themselves, explain the difference in my experiences owning and replacing my Honda Civic and IBM PC AT.

For that, we must focus on the following differences between the car and the computer (I refer to the personal computer in the points that follow, but the comments generalize to other information technology intensive products as well). The differences were at least partially illustrated by the Windows 95 example.

- (a) Although both my 1984 Honda Civic (1984 was the first year of a new model) and my first-generation IBM PC AT were followed by new-and-improved versions, there were marked differences in the extent to which the respective versions were new and improved: unlike the car (with the increasing use of microprocessors in cars, that too is changing), each new version of the personal computer brought with it a significant improvement in functionality—and, frustratingly but not surprisingly, a precipitous drop in the disposal value of older personal computers.
- (b) Consistent with the observation in point (a), over the eleven years I owned my car, it needed routine maintenance but no major upgrades (indeed, except for things such as air conditioning, the sound system, and the security system—none of which had a bearing on taking me from point A to point B—there was not much I could upgrade). My computer, by contrast, started calling for major upgrades within months. The result: the computer, which had cost nearly as much as the car and probably could outlast it physically, effectively had a much shorter life than the car.
- (c) With the passage of time, all I had to worry about in the case of the car was the car itself. I assumed I could get whatever spares I needed, the mechanics who could fix it in case something went wrong, and the fuel required to run it. Not much else in the “system” changed in any significant way, and I could be fairly sure of that. By contrast, in the case of the personal computer, I had to keep my eyes on many

moving targets, each in theory durable but in practice quickly obsolete: the computer itself, random access memory, hard disk space, floppy disk drive size and format, display resolution and quality, printer drivers, operating system software, application software, user and product-product interfaces and so on. I felt like Alice on the Queen's croquet field in Lewis Carroll's *Alice's Adventures in Wonderland*:

The chief difficulty Alice found at first was in managing her flamingo ... and, when she had got its head down, and was going to begin again, it was very provoking to find that the hedgehog had unrolled itself ... and, as the doubled-up soldiers were always getting up and walking off to other parts of the ground, Alice soon came to the conclusion that it was a very difficult game indeed.¹¹

- (d) New-and-improved models notwithstanding, I could be confident of one thing in the case of the car: driving infrastructure and protocol (habits, rules, and regulations) would not change so fast and so often so as to threaten periodically my compatibility with the rest of the world. There may be changes from one version of the car to the next, but some "meta" standards were in place. No such luck in the case of the personal computer, where generational changes—the generations could be separated by as little as two years—in different components of the "system" could leave me with the two equally unattractive alternatives: upgrade (at a not-insignificant expense), or become increasingly incompatible with the rest of the world.
- (e) The term "compatibility with the rest of the world" takes on somewhat different meanings in the two cases. In the case of the car, while I shared the roadway, the

¹¹ Carroll, Lewis. *Alice's Adventures in Wonderland*, New York: W.W. Norton & Company, 1971, p. 66.

fuel source, and the driving protocol with the rest of the world, I typically drove my own car and did not exchange or share with another driver parts of the car or “files” created through the driving process. This allowed for some incompatibilities at the level of the car as long as they did not interfere with system-level compatibility needs. The case of the computer is very different: I may work on my “file” on my friend’s computer, my friend may work on my file on his or her computer after I have worked on it on my mine, and my friend and I might share a server and a printer. A different—some would argue, greater—compatibility demand.

Differences (a) through (e) taken together go a long way toward explaining my different experiences owning and replacing my 1984 Honda Civic and my first-generation IBM PC AT. They also make poignant the earlier discussion on the relationship between the consumer’s investment in an overall durable-product-based system and the pace of product improvement: information-technology intensive products entail substantial, generation-specific, and not-easily-transferable system-wide investments; individual components of the system, each of them a durable product, improve rapidly; the improvements often are not just flashy features but significant functionality enhancements; and the consumer—not unlike Alice on the Queen’s croquet field—must make sense of and react to all these improvements.

Points (a) through (e) also suggest the need for a more eclectic definition of the term “pace of product improvement.” Earlier, I characterized pace as the ratio of the amount of improvement and the inter-version time (the time interval between the introduction of an existing version and a new-and-improved version). The definition is less clear-cut once you allow for different dimensions of product improvement, some more critical for a product’s functioning than others. Then, there is the fact that most product improvements are implemented in a product line context, with different types and amounts of improvements being introduced perhaps at different times in different “models” of the product line. Now, how does one measure the pace of product improvement?

Finally, competing product and complementary-product suppliers all play (less than coordinated) new-and-improved games, further muddling the concept.

The eclectic orientation provides a valuable insight: even though there may be no picking up in the pace of improvement of any one relevant product dimension for any one system component, the confluence of multi-dimensional, product line-based, multi-component changes can, at the level of the system, convey the sense of a faster and faster pace. Thus, the beat of so-called Moore's law may remain two years, but what with one aspect of a product changing now, a second six months later, and different changes being implemented at different times in different models in a product line, and with different suppliers following not-always-coordinated timetables, the effective system-wide pace for the consumer may be less than two years. And, given the competitive imperative to be first to market with a new-and-improved version of whatever, the consumer may see pace as becoming even faster and faster.

Even-Newer-and-Even-More-Improved High-Tech Products: Durability, Revisited

The above discussion throws new light on the concept of durability. All things considered, how durable are information technology intensive high-tech products? And from whose point of view—the product's, the system's, the investor's, the consumer's, the producer's, or the industry's? Each point of view implies a product life, and one reason why the pace of product improvement is relevant is because all these lives are different and "out of synch."

Take the word-processing software I used to write this article. In theory, it has unlimited durability: unlike my car, I can use the software as often and for as long as I like, and it would never wear out. So, that is one life.

But I do not use the software by itself; I use it with my computer, an operating system software, a display, and a printer. These have lives of their own, some of which are limited (hardware, unlike software, can wear out and is prone to break down eventually); consequently, there is a limit on how often and for how long I can go on using the word-processing software in the context of the existing system. So, that is a second life, and it is shorter than the first life.

My school purchased the word-processing software and the other components of the system, and the whole setup cost a bundle. Obviously, the Dean is not keen on spending a large sum of money all over again any time soon. As an investor in the system, he has a certain pay-back period in mind. Equivalently, if I were working for a for-profit organization, there would be some policy on capital investment depreciation and replacement cycles. So, that is life number three, and it is determined by, among other things, organizational policy and tax rules.

Then there is me, the consumer. On the one hand, I have invested valuable hours jiggling the system together and learning how to use the different components—individually and as a system—and I would like to amortize this investment over as long a time period as possible; on the other hand, as I get used to what I have, as my needs grow, and as I hear of all the new-and-improved versions of the system components out there, I want to upgrade. There is a tension between the two preferences, tension that would only be accentuated if I also had a financial investment in the system. Once I resolve this tension (assuming that I can), the result is a fourth measure of product—and system—life, and this may be different from the first three measures.

Next, there is the supplier who, given technological trends, in-house research and development efforts, and a broad set of other considerations determines when to introduce a new-and-improved version and how new and how improved it would be, in other words, the nature, amount, and pace of product improvement. These decisions, in turn, imply a life—measure number five—for the existing version of the product.

Finally, Alice-on-the-Queen's-croquet-field style, it is not only one component of the system that is changing. Competing and cooperating suppliers in the industry are introducing new-and-improved versions of their own, and these introductions collectively feed back to all the above lives. The resulting life is life number six.

If all these six lives—and there may be more—were of equal length and perfectly synchronized, then there would be no need for this article. The problem is, they are not. Because of improving quality, life strictly from the product's point of view is getting longer. Because of increased product complexity and growth in terms of number of applications and users, lives from

the investor's and consumer's point of view are also getting longer. Meanwhile, because of technological progress and intense competitive pressure to be first to market with an even-newer-and-even-more-improved product, lives from the system's, producer's, and industry's points of view are getting shorter. In a sentence, existing systems have increasingly satisfactory consumption values, investors and consumers have larger outstanding investments in existing systems, frequent introductions of substantially improved new-and-improved versions of different system components drive down disposal value, and, meanwhile, new-and-improved versions continue unabated.

Rapidly Improving High-Tech Products: Impact on Consumer Attitudes, Expectations, and Purchase Behavior

Having offered a framework for thinking about why the pace of product change may be of concern to consumers of durable-product-based systems, and having argued that the concern may be particularly poignant in the context of information-technology intensive high-tech products, let us consider the impact of the rapid introduction of new-and-improved versions on consumer attitudes, expectations and purchase behavior. Four questions, all framed from the consumer's point of view, help structure the inquiry:

1. "What should I do about the new version that has just been introduced?"
2. "If I had known that the new-and-improved version would be coming out so soon would I have chosen differently in the past?"
3. "What will I do the next time around?"
4. "How do I feel about all of this?"

Hesitation (1)

Of the four questions, the first is the easiest to answer, and the two consumer segments that will have the greatest struggle over the question are the existing-version and competing-version adopters. Both segments own a working version of the product, which has a disposal value no doubt (this lowers their cost of switching to the new-and-improved version), but which also has a

residual consumption value (and this lowers the benefits from switching). Our earlier analysis suggests that if the new-and-improved version comes “too soon” after the existing or some other competing version, then these consumers may decide that it is in their economic interest to continue with the version they already own rather than to switch to the new-and-improved version under consideration. For them, that early in the “life” of the version they already own, the switching costs may outweigh the switching benefits, and they will put off purchase of the new-and-improved version until some future date. Their hesitation has nothing to do with remorse or regret over past actions; it is the result of hard headed, rational decision making.

There are ways by which the new-and-improved version producer can get existing- and competing-version adopters to reduce their hesitation, and we see examples in practice. One way around the problem is to reduce the switching costs, either through aggressively low prices for the new-and-improved version (software vendors, for example, provide special price deals for consumers who are upgrading from an existing version or switching from a competing product), or by helping to create or support an active second-hand market (this can increase disposal value and decrease transaction costs; Hewlett-Packard, for example, advertises a special deal offering to purchase people’s existing printers if they were to switch to one of the company’s newer printers).

Another option is to offer even greater levels of product improvement, thus increasing switching benefits. Not only may this be not easily possible, it may also be an expensive route to take. More to the point, both this and the low-price-for-the-new-and-improved-version options increase the existing-version consumers’ sense of regret over having purchased the existing version in the first place (see next section), and I believe this is not in the producer’s long-term interest.

Finally, there is the risky—but that does not mean producers do not resort to it—strategy of talking up the new-and-improved version and talking down the existing version: consumers will perceive higher switching benefits and will be less cognizant of the switching cost.¹²

¹² All the buzz surrounding Microsoft’s Windows 95 introduction (in its August 28, 1995 issue, *Business Week* cites the following statistics [“Feel the Buzz,” p. 31]: Microsoft’s projected advertising and marketing expenses for

Regret

My first-generation IBM PC AT came with 512 KB of random-access memory, a 20 MB hard disk, a 6 MHz clock speed, an RGB (red-green-blue) display, and two 5.25" floppy-disk drives (one 360 KB and one 1.2 MB). Less than six months after I had purchased the computer, IBM introduced a faster version with a more capacious hard drive; it was also \$500 cheaper. Soon thereafter, the company introduced a new display standard and, two years later, it discontinued the AT line and came out with a PS/2 line that had a new internal architecture and at least 640 KB of random-access memory, could not accept any of my AT's expansion cards or display, and came with 3.5" floppy-disk drives. Two years after that, the Lotus Development Corporation whose 1-2-3 spreadsheet software I was then using came out with a new version of the software, and this required 2 MB of random-access memory. I can go on, but I have made my point.

One recurring thought in my mind as these changes were taking place was, "Wouldn't I have been better off if I had waited—even only for six months?" The answer to the question depends on the tradeoff between the benefits I realized from the use of the computer in the intervening period and the greater value I could have derived from a newer version, adjusted for differences in the prices of the two versions and the time value of money and consumption benefits. Given the non-synchronized changes in other components of the entire personal-computing system, analyzing the tradeoff is not easy, but there were a number of times when the answer would easily have been, "Yes, I should have waited."

The reader probably has his or her favorite examples. I am going by the evidence of reported anecdotes, but my sense is that such feelings of regret extend to other product categories, all seeing—or used in systems involving—the increasing application of microprocessors in particular and information technology in general.

the first year, \$200 million; in-store demonstrations before August 24 launch, 1.2 million; point-of-sale displays, 250,000; people invited to product launch parties in 40 cities, 70,000; and How-to-Use Win95 books available by around day of launch, 450) cannot but fail to underscore the "This is a happening" nature of the new product—and, perhaps, downplay the price tag of upgrading all the hardware and operating-system software.

"If only I had waited ..." A sense of regret, and a wish to go back and revisit past decisions. Of course, what is decided is decided, whatever money that has been spent has been sunk, and nothing is gained by crying over spilt milk. These rationalist strictures notwithstanding, regret nevertheless is a real—and often powerful—human reaction; it can—and does—influence future action. If nothing else, there may be a dogged determination by the consumer to hang on to the version he or she already owns and not risk get burnt again.

Hesitation (2)

The consumer's determination to hang on to a product version he or she already owns is predicated on the following line of reasoning, "I invested a lot of time and money in buying the version I have and in setting up the whole system, and I am determined not to have the investment come to naught. I am going to continue using the existing version come what may." The determination not to have past investments come to naught leads to hesitation, a hesitation that is motivated by considerations different from the switching benefits-switching costs based analysis we saw earlier, but is hesitation nevertheless.

Be it the first type of hesitation or the second type, it does not bode well for the producer: if too many consumers balk, then demand for the new version will be adversely affected.

There is another respect in which consumer hesitation is bad for the producer, and that has to do with the segment of the market most likely to put off purchase of the new-and-improved version. It is possible that the consumers who find it most advantageous to put off purchase are those who are at the "high end": these consumers have the greatest value for the product and in whatever improvement that is being introduced, and they may be most interested in waiting for the next new-and-improved version. Unfortunately for the producer, high-end consumers are also those who have the greatest willingness to pay for the product. This may have a detrimental effect on the producer's ability to price skim: sell first at high prices to high-end consumers, and later at lower prices to low-end consumers. Furthermore, some waiting high-end consumers may defect to a

competitor, possibly taking their future custom with them. Where will the cash flow and market presence come from to fund and launch the next new-and-improved version?

When it comes to hesitation over purchase of the new-and-improved version, it is not only existing- and competing-version adopters the producer must worry about. Non-adopters, on hearing reports of the adopters' regret (over past choices) and hesitation (over present choices) may also hesitate, and this can really doom the new-and-improved version. The non-adopters' concern: will they have the same sense of regret when the next new-and-improved version comes along; if so, maybe they should just wait it out.

Anxiety

Observations about the pace and nature of past product evolution and word of mouth about other consumers' experiences affect consumer expectations about future evolution and shape consumer attitudes toward present and future purchase, with one thought playing back in the consumer's mind: "This had better not happen to me."

It is useful to identify two different expectation effects:

- a concern that there will be similar or even more rapid product changes in the future, with repeated need to write off long-term system-wide investments; and
- a lack of stability in the expectations themselves ("The future is uncertain, and I am even uncertain about how uncertain it is.").

The former effect may influence consumer purchase behavior but, at least, it is something the consumer can plan around. The latter, on the other hand, can throw the consumer's decision-making process into disarray.

The chances of disarray only increase when you allow for the Alice-on-the-Queen's-croquet-field effect. Now the consumer must formulate expectations about the evolution of all the elements of a multi-component system and plan the acquisition of individual components with a watchful eye on the evolution of the entire system. The number of relevant decision variables, interactions, and scenarios explode, and so may the anxiety level.

Ultimately, anxiety about what the future may hold in terms of new-and-improved high-tech products—and its adverse impact on expectations and product-purchase decision making—can be even more damaging than regret about the past and hesitation over the present. It may not turn consumers *en masse* into luddites, but it cannot be good news for the producer.

What, If Anything, Can the Producer Do?

Earlier, when talking about hesitation, I suggested a range of possible solutions, none of which was totally satisfactory: aggressive low pricing of the new-and-improved version (the initiative can be restricted to consumers who own an existing or competing version; but, taken to its limit, such a strategy can culminate in an industry bloodbath and result in greater consumer regret), an new-and-even-more-improved version (this can use up scarce resources and will result in greater consumer regret), an active second-hand market (but this may divert non-adopters from the new-and-improved version), and talking up the new version and talking down the existing version (What happens when the truth comes out?). I will now outline some additional options.

An “Optimal” Pace of Product Improvement

If there is one thing the discussion so far points to it is that consumers require time to digest and recoup their durable investments in information technology intensive products and the overall systems in which the products are used, and producers must factor this in when pacing the introduction of new-and-improved versions.

Factoring the demand-side considerations detailed in this article into an “optimal” pace of product improvement is no trivial matter. It requires the producer to strike a judicious balance between, on the one hand, the momentum of technological innovation, the imperatives of competition, and the capability of the supply chain to deliver product improvement and, on the other hand, the willingness and ability of the demand side to accept and adapt to the change.

The desired balance can only be struck if the producer organization has the decision making processes and the discipline necessary to let demand-side considerations have a voice—and not to

let decisions on the pace of product improvement be made by default, as an outcome of a no-holds-barred competitive race of technological virility (“Who gets to concept and market first with an even-newer-and-even-more-improved version?”). The point bears special emphasis in today’s business environment, for not only are the competitive pressures in the concerned industries greater, the stakes larger, and the windows of opportunity smaller, but the supply side has also worked hard in recent years to deliver the rapid product improvement that the business environment is thought to call for.¹³ Unless there is a deliberate check against it, speed can become *the* game, with contestants falling over each other to introduce even-newer-and-even-more-improved products in the market.

That deliberate check is, “Suppose we can rush a new-and-improved version to the market, would the consumers be willing to accept it and adapt to it?”. Answering the question requires

- a constant reminder that it is the total system—the interconnected totality of the product, the relevant complementary products, the user, all the relevant interfaces, and the appropriate rules and communications protocol—that the consumer cares about, and it is the total system that is the relevant reference frame determining the consumer’s response to the new-and-improved version;
- information on the relative sizes of the various consumer segments (in particular, existing-version adopters, competing-version adopters, and non-adopters) and a dynamic understanding of existing- and competing-version consumers’ residual consumption value and disposal value curves at the overall system level;
- a conceptualization of the different “lives” as characterized earlier in the discussion and working measures of the same; and

¹³ The efforts at making the supply side more agile have been pervasive: products are being designed so they lend themselves to successive improvement, systems used to design products are being configured to facilitate rapid product improvement, processes and operations are being made more flexible with respect to product variety and change, and traditional modes of intra- and inter-organizational communication are being reexamined to improve coordination and to eliminate the lags that slow down product change.

- an appreciation of the interactive effect of past experience and future expectations on the consumer's attitude toward, and purchase of, a new-and-improved version.

The discussion on regret ("whether there is regret or not depends on the tradeoff between the benefits realized from the use of the product in the intervening period and the greater value the consumer could have derived from a newer version, adjusted for differences in the prices of the two versions and the time value of money and consumption benefits") suggests one test for the pace of product improvement. The pace is "too fast" if all or most consumers see the product as improving in "present value terms": the present-day discounted consumption value of an anticipated new-and-improved version exceeds the consumption value of the existing version and consumers, not wanting to regret their choice when the new-and-improved version will come out, will be tempted to hold off purchase of the existing version.

My comments on the optimal pace of product improvement relate to the time interval between consecutive versions of a product and not the speed at which a product concept is brought to market: once a new-and-improved version is conceptualized and the above "deliberate check" conducted, then it is incumbent on the producer to bring it promptly to market; similarly, once a concept is articulated, then it is a good strategy to have a new-and-improved version and ready for launch at an appropriate time. Rapid product development and speedy market introduction make the organization nimble, responsive, and efficient, and there is little to argue against that.

Two Good Reasons for a High Pace: To Stimulate Demand and to Capture/Hold on to Market Share

A lot of the discussion in this article focused on the existing-version consumers' (the installed base's) reaction to the pace of product improvement. If, in the relevant consumer population, the installed base is small, then—maybe—it is less consequential that the installed base reacts adversely, the argument being that the new-and-improved version may induce competing-version adopters to switch and/or it may stimulate significant new demand among non-adopters. In such instances, rapid product improvement may, in fact, be prudent.

Even when the existing-version installed base is not small, there may be a defensive argument for rapid product change: "If we don't do it, the competition will, and our installed base may defect to the competitor's 'new-and-improved' product." This argument has merit and, indeed, competition is one of the strongest motivator for the race for speed; every producer, it seems, wants to leapfrog every other producer.

The problem with this scenario is that, on the one hand, racing ahead with a new-and-improved version is seen to be critical for survival, let alone competitive success while, on the other hand, at least over the long run, an industry cannot be well served if large numbers of consumers start putting off product purchase and the installed base must often lick its wounds. The tendency to postpone purchase is particularly worrisome because of the negative impact on initial sales and profit margins from the new version. The negative impact comes at a critical time—when individual producers need more and more resources to fund faster and faster product development.

Modular Upgradability

Perhaps the best way to sustain a rapid pace of product improvement and yet not have the installed base suffer and consumers put off purchase is to offer modular upgradability—to allow existing (and future) version owners to selectively upgrade the version they own rather than dispose of it entirely and purchase a new-and-improved version. Modular upgrades can make consumers more flexible with respect to their investment in a durable product, and they can be targeted at consumers who most value the upgrades. They are an especially attractive solution in contexts where there is a growing disparity between the product's various "lives."

One problem with modular upgrades is that they disaggregate the product, which may increasingly be seen by consumers and competitors as an assemblage of "plug and play" components rather than as an integral entity. There is nothing inherently wrong with this except that once an empty socket is created the module that is plugged in may also be supplied by a competitor; plug-and-play easily leads to mix-and-match, and consumers may mix different producers' modules.

Phasing in Product Improvement in a Product Line

Producers introducing new-and-improved versions of high-tech products can avoid some of the pitfalls alluded to in this article by availing themselves of the multi-dimensional nature of the product. Consumers typically are heterogeneous in their preferences for and valuation of different product dimensions, and it may be possible to pace and phase improvements along individual dimensions such that the specific improvements from one product version to the next are not seen by any one consumer group as being too rapid.

Cameras are a case in point. The Nikon Corporation introduced its "N" series of camera bodies beginning in 1985. The first in the series, the Nikon N2000, offered a built-in motor drive for winding film. The second, the Nikon N2020, was introduced a year later, in 1986, at the same time as a new series of autofocus lenses; the N2020 provided autofocus capability for the first time to Nikon's "amateur photographers" market segment. In 1987, there was the Nikon N4004, an "entry-level" camera body with an improved autofocus module. Another year later, in spring 1988, there was the N8008, a camera for the higher-end segment; the N8008 introduced "matrix metering," a new form of microprocessor-assisted metering. Finally, in fall 1988, there was the top-of-the-line professional Nikon F4 with all of the above improvements—and some.

Concluding Comments

I have in my shirt pocket my father's 35-year-old fountain pen. In the years since its purchase, the pen's manufacturer has introduced many new-and-improved versions, but—in terms of writing—there is nothing my pen's newer cousins can do that it cannot. Moreover, the pen slides into its customary position between my fingers as I start to write and its nib has been sculpted through many uses so it glides over the sheet of paper on which I write. In a very deep sense, I am accustomed to the pen, and there is a certain security resulting from that knowledge.

I value that security as I struggle to master my other word processor, the software package I used to write this article. I thought I had succeeded, but I recently upgraded the software. Installing the 30-plus shrink-wrapped disks on my computer's hard disk took 45 minutes. Then, I

had to customize the new version, a hopeless task since I don't remember all the preference settings in the version I had just upgraded from. Next, I discovered that my laptop did not have enough memory to run the software. A final blow: the software insists on placing random page breaks on pages with footnotes; I cannot solve the problem, and neither can the supplier's Help desk. I spent over an hour forcing page breaks in this document before it looked right, and I am scared of making changes. Mind you: this is version 6.0 of the software, and it is developed by the industry titan.

Yes, I crave for the security of my fountain pen as I cope with some other products in my life: computers, software, telephones, "home entertainment systems," office copiers, and so on. To be sure, I value many of the improvements in new versions of these products, but frequent improvements result in my having to junk entire systems that are in otherwise perfect working order; they require me to learn, unlearn, and learn differently how to use the consecutive versions; and they leave me confused, with less and less reliable algorithms for planning for the future.

In its June 10, 1991 issue, *Business Week* carried a cover story on "Computer Confusion." Quoting a Price Waterhouse survey of 300 British businesses, the story reported

71% [of the respondents] indicated that while uncertainty was not a problem five years ago, it has become a major one ... today. ... 39% [of the respondents] said they are dealing with computer confusion by simply avoiding purchases ...

There's message in that statistic to send chills down the spines of computer-industry executives: Unless computer confusion is cleared up, they risk a serious sales slowdown. ... "Any time there's confusion, there's the opportunity to delay a buying decision ..." says Intel Corp. Senior Vice President David L. House.¹⁴

Maybe, it's in clearing the confusion and planning for an uncertain future that consumers need the greatest help.

¹⁴ "Computer Confusion," *Business Week*, June 10, 1991, p. 74.

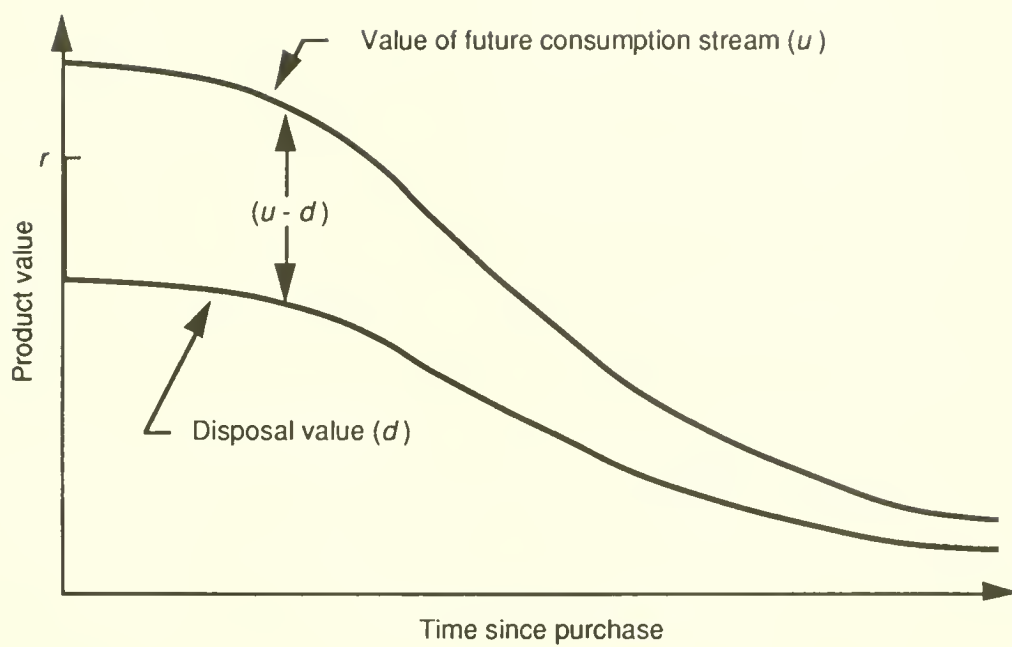


FIGURE 1. Durable Product: Value of Future Consumption Stream and Disposal Value.

Total 1995 worldwide "IBM PC-compatible" installed base: 202 million units, of which

39% use a "486" or "Pentium" microprocessor, have 8 MB (megabytes) or more of memory, and can efficiently run Windows 95,

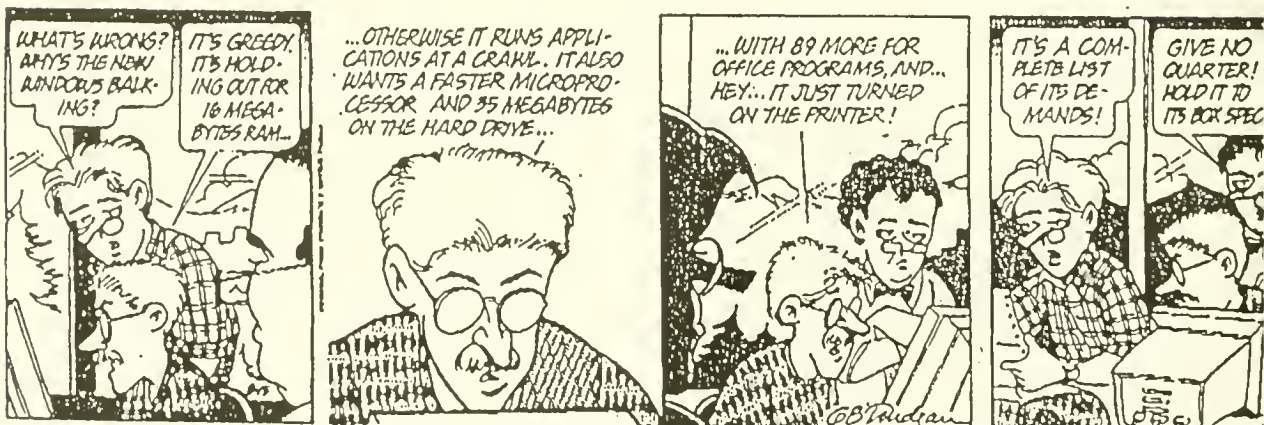
22% use a 486 or Pentium microprocessor, have 4-7 MB of memory, and will need memory upgrade to run Windows 95 efficiently (the program needs at least 4 MB of memory but will work much better with 8 MB or more),

14% use a 386, 486, or Pentium microprocessor, have 3 MB or less of memory, and will need at least a memory upgrade to run Windows 95 (upgrading the 386 processor would also help), and

25% use a 286 or below series of microprocessor and cannot run Windows 95 (the program needs a 386 or higher series of microprocessor).

Source: "The Defenestration of Bill?", *The Economist*, July 8, 1995, p. 57, with adaptation. For a tongue-in-cheek look at the difference between what Microsoft say Windows 95 needs and what may be needed for running the program efficiently, see the Doonesbury strip in Figure 2.

TABLE 1. Windows 95: Not for Everyone



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FIGURE 2. Windows 95's "Real" System Needs?

Date Due

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